

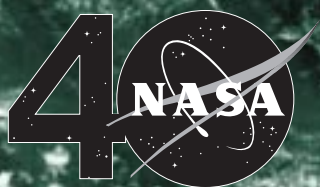
# Aerospace Technology INNOVATION

## **NASA Provides Insight to Understanding Hurricanes**

**Spacesuit Offers  
a Walk in the Sun**

**NASA Tries  
Hair-Raising Idea**

**Earth's Smoke  
Viewed From Space**



# INNOVATION

Aerospace Technology

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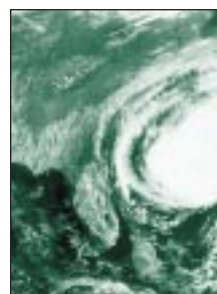
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#### About the Cover:

Hurricane Bonnie brought to bear the successful use of a range of modern instruments, such as lasers and advanced radar to improve forecasting to avoid large losses in economic productivity.

**On-Line Edition:** Go to <http://nctn.hq.nasa.gov> on the World Wide Web for current and past issues.

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## COMMERCIAL DEVELOPMENT MISSION UPDATE

| Date* | Flight   | Payload  | Sponsor/Coordinator  |
|-------|--|--|--|
| TBD   | STS-93<br>AXAF                                     | AEROGEL<br>Commercial Generic Bioprocessing Apparatus-04**   | Marshall Space Flight Center<br>BioServe Space Technologies<br>Center for Microgravity Automation Technology (CMAT)  |
| 10/98 | STS-95<br>BioTechHab<br>(SPACEHAB<br>short module) | Includes eight commercial development payloads:<br>Advanced Organic Separation Unit (ADSEP)<br>AEROGEL<br>ASTROCULTURE™<br>BioDyn-A<br>Commercial Generic Bioprocessing Apparatus<br>Commercial ITA Biomedical Experiments<br>Commercial Protein Crystal Growth-15<br>Microencapsulation Electrostatic Processing System | Commercial Space Centers and NASA Centers<br>Consortium for Materials Development In Space<br>Marshall Space Flight Center (MSFC)<br>Wisconsin Center for Space Automation & Robotics<br>Consortium for Materials Development In Space<br>BioServe Space Technologies<br>Instrumentation Technology Associates, Inc. (ITA)<br>Center for Macromolecular Crystallography<br>Johnson Space Center/MSFC |

Note: Sortie flights beyond STS-95, and Space Station Operations, under review at this time.

\* As of September 1998

\*\* In combination with National Institutes of Health payload NIH-B1 in support of Life Sciences Division requirements

Key: STS—Space Transportation System

AXAF—Advanced X-ray Astrophysics Facility



# WELCOME TO INNOVATION

## NASA's Role in the Prediction of Hurricanes

By Ghassem Asrar

SINCE ITS CREATION IN 1958, NASA HAS BEEN studying Earth and its changing environment by observing the atmosphere, oceans, land, ice and snow, as well as their influence on climate and weather. We now realize that the key to gaining a better understanding of the global environment is exploring how Earth's systems of air, land, water and life interact with each other. The first weather and communications satellites launched by NASA fundamentally changed our way of thinking and expanded our perspective concerning the global environment and weather.

Earth's environment is constantly changing, and those changes affect us all. Some of these changes, such as hurricanes, are rapid and violent. While we have made great progress in the study of hurricanes, we have just begun our journey to produce precise predictions—well in advance of the storms—of exactly when and where hurricanes will hit our shorelines. NASA has developed a suite of instruments to provide insight into the science of hurricanes. We will continue to fly ever more advanced spacecraft and instruments to bring us closer to precision forecasts that will save lives and prevent unnecessary economic hardships.

The state of technology for studying hurricanes today shows how far we have come but also points out that we have a long way to go. Hurricane Bonnie provided NASA researchers with the opportunity to make incremental advances in the understanding of hurricanes. Two NASA missions showcased in this issue provided valuable information on the dynamics of Hurricane Bonnie: the third Convection and Moisture Experiment (CAMEX-3), a mission involving the use of aircraft, and the Tropical Rainfall Measuring Mission (TRMM), a space-based satellite.


Concerns about Earth reach beyond the scientific community to the business world. Natural disasters cost the United States tens of billions of dollars each year. The trillion-dollar banking and insurance industries are beginning to see the value of Earth observation in such areas as forecasting hurricanes. Such businesses are built on a stable world climate. Their well-being depends on good information about the future of Earth's environment and its weather. Instead of being held captive to whatever climate changes may occur over time, NASA and its partners are striving to discover climate patterns that will allow us to predict, and perhaps respond to, environmental changes well in advance of their occurrence.

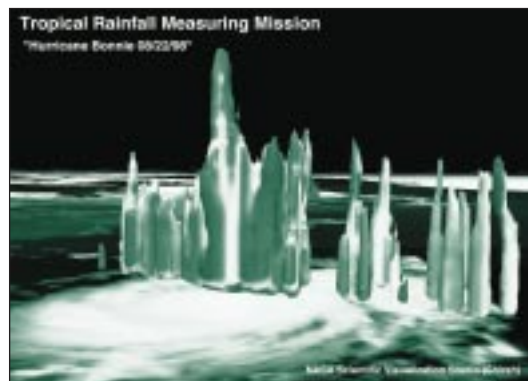
HURRICANE BONNIE PROVIDED NASA RESEARCHERS WITH THE OPPORTUNITY TO MAKE INCREMENTAL ADVANCES IN THE UNDERSTANDING OF HURRICANES.

The information on hurricanes provided here is but a small piece of the complex climate patterns that we are only just beginning to understand. NASA's Earth Science Enterprise seeks to combine information

about our oceans, wind, land, and atmosphere to provide predictive capabilities that may allow us to forecast climate changes years and decades in advance.

For more information on hurricanes, visit the following web sites:

- Hurricane Bonnie Image Catalog:  
<http://rsd.gsfc.nasa.gov/rsd/images/Bonnie.html>
- TRMM Home Page: <http://trmm.gsfc.nasa.gov/>
- CAMEX-3 Home Page:  
<http://ghrc.msfc.nasa.gov/camex3/> 



Hurricane Bonnie and the Chimney Cloud.

## NASA Provides Insight to Understanding Hurricanes

**T**HROUGHOUT HISTORY, IT SEEMS THAT humans have been obsessed with understanding, predicting, controlling and influencing the weather. Exploring the atmosphere through its space program, NASA is a key player in showing that weather prediction is a science with many life-saving and cost-saving benefits.

With an aim to better understand and improve ground-based predictions of hurricanes, two specially equipped NASA aircraft—a converted spy plane and a refitted jetliner—took weather researchers on a historic ride into the eye of Hurricane Bonnie in August 1998. The intent of the researchers was to collect high-altitude information about Atlantic hurricanes and tropical storms for more insight into hurricane structure, dynamics and motion.

### The Birth of a Hurricane

Sunlight heats the ocean. Water evaporates, rises and forms rain, surrendering its heat to the air and accelerating the rise. Air flows in on the surface to replace rising air, barometric pressure drops and air masses slowly start circling.

The tropical depression becomes a tropical storm, winds grow steadily until they pass the 110-kilometer-per-hour (km/h), or 60-knot, mark and keep rising to 368 km/h (200 knots) or more. A hurricane is born.

The pattern repeated itself as the 1998 hurricane season in the Atlantic Ocean began in mid-August. This

year was different, though. For the first time since the 1950s, research scientists looked at the upper levels of the storms, not just the middle and lower altitudes that are braved by hurricane hunter teams.

### Why Hurricanes Have More Impact Today

It all comes down to thermodynamics, the physics of heat. Water absorbs energy from the

air or sunlight when it goes from sea surface to vapor, and it surrenders energy to the air when it turns vapor to rain drops.

Where the energy changes hands is what powers the hurricane, but hurricanes are no more powerful than before. There are more people living in coastal regions than ever before, and they have built more homes and businesses for hurricanes to destroy. Therefore, the need to understand the mechanics of hurricanes increases each year as human populations grow in coastal areas.

### Cutting-Edge NASA Research Could Save Lives and Money

Specially equipped NASA aircraft have taken to the skies—collecting high-altitude information about Atlantic hurricanes and tropical storms—as part of the third Convection and Moisture Experiment (CAMEX-3). This mission may increase warning time, saving lives and property, and decrease the size of evacuation areas, thus saving money.

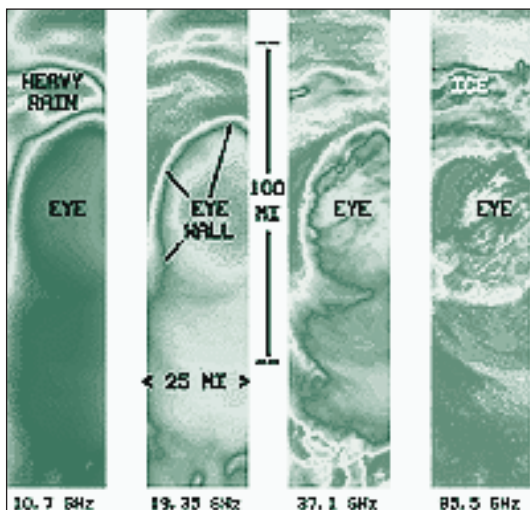
National Oceanic and Atmospheric Administration (NOAA) officials estimate that improved forecasting can be worth millions of dollars per mile. That is, every inch of coastline that does not have to be alerted avoids a million dollars in lost economic productivity. Until a hurricane's power is more understood, forecasters practice "overwarning" rather than risk a potential sudden "hit" that catches people off guard.

CAMEX-3, designed to study the factors involved in how strong a hurricane grows, is an interagency project to measure hurricane dynamics at high altitude—a method never before employed over Atlantic storms. It operates out of Patrick Air Force Base in Florida. The CAMEX-3 study uses NASA's converted DC-8 and ER-2 high-altitude research aircraft in conjunction with NOAA's WP-3D Orion hurricane hunter and various other instruments. It also uses data from weather satellites and has timed its flights to coincide with observations by the Tropical Rainfall Measuring Mission (TRMM) satellite.

"This is a significant achievement for this hurricane study," said CAMEX-3 project scientist Robbie Hood, mission scientist from NASA's Global Hydrology and Climate Center at Marshall Space Flight Center in Huntsville, Alabama. "We achieved our number one objective, that we could accomplish the tricky maneuver of placing all three NASA and NOAA aircraft in the study of the structure of the same storm at the same time."

"A lot of these instruments either have versions flying on satellites now or are prototypes for new satellites."

*High-altitude over-the-top images of Hurricane Bonnie show the eye, eyewall, sea surface and presence of ice particles associated with the heavy rain band shown.*



We're bringing NASA technology to the picture, satellite and remote sensing technology in particular, and we're trying to give the hurricane research community data that they don't have, data at high altitude where their aircraft don't fly.

"The big thing is that we're bringing space flight technology to bear," Hood said. "We can bring NASA technology to an experiment and to help save lives in the future.

"The hurricane community has made great strides in making more accurate forecasts and tracking," Hood said. "But how intense that hurricane's going to be when it hits the shoreline—or why some storms die out and others just keep going and going—is the important factor.

"This is part of ongoing research that NASA is conducting to study the whole Earth and its atmosphere," Hood explained, "but our real goal is to provide data that could be used eventually to save lives."

## Eye to Eye and Bonnie Winks

Hurricane Bonnie formed in the Atlantic Ocean in mid-August. On August 23 and 24, teams of weather researchers went on a historic first ride through and over Hurricane Bonnie's eye—the central, open structure that is the focus of a hurricane's power and motion—as she churned in the Atlantic near the Bahama Islands. And, while looking Bonnie in the eye, she winked.

Finally, on August 26, the team probed Bonnie as it hit the North Carolina shore. The jetliner, flying at 11 km (37,000 feet), was joined at the storm by a NASA ER-2 jet overhead at 19.8 km (65,000 feet) and a NOAA WP-3D Orion turboprop at 4.6 km (15,000 feet) for a 7-hour mission. Bonnie did more than cooperate, veering toward the Outer Banks of North Carolina at the last moment, and even posing for pictures.

"We were afraid we were going to miss it," Hood said. "But once we got there it was like it stopped to wait on us. We noticed while we were flying through it, the center of the eye was not moving that much, and for the last part of the flight it was pretty much sitting still.

"This thing was just sitting here, just waiting on us. I don't know if we'll ever be able to catch another one that perfectly."

During the Bonnie study, two co-existing eye walls were explored. The team had excellent coordination in having one NOAA WP-3D Orion on the first eye wall flight, and both Orions plus an Air Force WC-130 Hercules were on the second eye wall penetration, for a total of five aircraft. It was during the second eye wall flight

that Bonnie pulled yet another surprise—snow in August. "Right along the eye wall this big dome cloud had come up, and it was shooting ice crystals or snow up, and it was falling on top of the DC-8," Hood explained.

Compelling images of a 59,000-foot storm cloud towering from Bonnie's eye wall were obtained by the TRMM, offering some valuable information to researchers. By comparison, the highest mountain in the world is 29,000 feet, and the average commercial jet flies at barely one-half the height of Bonnie's cloud tops.

Another impressive step was taken when NASA researchers gave Bonnie some eye drops. Ten small tubes containing miniature weather stations were dropped into Bonnie's shifting eye to check her vital signs, wind speeds, barometric pressure and humidity levels. The tiny weather stations dropped into the middle of the eye verified the readings the DC-8 remote-sensing instruments were reading at 11 km (37,000 feet).

## Success at the Halfway Mark

Although the scientists are halfway through the flight campaign, they have hardly begun the important work of CAMEX-3: analyzing the data. And they have plenty. "This experiment is going to produce a ton of papers," Hood said.

A campaign to make the most extensive set of hurricane measurements is already a phenomenal success, even though it is only halfway through its flight time. "The Bonnie data set is just incredible," Hood said.

While hurricanes have been probed by aircraft since the 1940s and monitored by satellites since the 1960s, this was the first coordinated campaign to measure a hurricane's growth with aircraft at low, medium and high altitudes. "We're going to push real hard to get the data on-line as soon as possible," Hood said. Browse or summary versions of the data will be available in 3 months, and the first complete data sets will be available starting in 6 months.

The hurricane study is part of NASA's Earth Science Enterprise. Its purpose is to better understand the total Earth system and the effects of natural and human-induced changes in the global environment. ✨



*The ER-2 is a converted Cold War-era U-2 spy plane. It provided real-time data downlinks using the same Tracking and Data Relay Satellite System used by the Space Shuttle and Hubble Space Telescope.*

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For more information, contact Karen Kafton at the National Technology Transfer Center. ☎ 800/678-9882, ✉ [kkafton@nttc.edu](mailto:kkafton@nttc.edu) Please mention you read about it in *Innovation*.

# Spacesuit Offers a Walk in the Sun

**M**ODIFIED NASA SPACESUIT TECHNOLOGY has opened doors to a whole new world for a six-year-old Virginia boy with a genetic disorder that causes extreme and potentially dangerous sunlight sensitivity.

Mikie Walker became the first American child to receive a pint-sized "spacesuit" that protects him from the Sun's ultraviolet rays and other light sources. The suit was modified with more durability at less cost, after NASA received feedback from two brothers in England who were given a protective prototype suit last September to help them with a serious light allergy that only allowed them to venture out at night.

The suit blocks nearly all of the Sun's ultraviolet rays. These rays can result in chronic skin inflammation, blistering, inflammation of nerves, abdominal pain and other disturbances if a body affected by the genetic disorder porphyria is exposed to direct sunlight.

Mikie received the improved version in April. "His new favorite outdoor activities include playing in dirt and rolling on the lawn," Mikie's mother, Angela Walker, said. "He enjoys this so much that, at the end of the day, he resembles a soil-encrusted Apollo moonwalker."

The Office of Technology Transfer and Commercialization at NASA's Johnson Space Center in Houston, Texas, offered the suit to Mikie through an agreement with the not-for-profit HED and Related Disorders Foundation in Hampton, Virginia.

The suit's headpiece was redesigned totally to enhance ventilation and reduce overheating in the head area. The body cooling system was changed from a battery-powered liquid pump unit to a passive phase change vest, made of material similar to the refrigerator cold packs used for sports injuries. The phase change vest is

simple, easier to use, more durable than the original battery pump and less expensive, making it more affordable for families, according to Robert Dotts, Assistant Director of Technology Transfer and Commercialization at Johnson.

"A child now can play in the sunlight because NASA astronauts have walked on the Moon," said

Sarah Moody, founder and president of the HED Foundation, which donates cooling gear and other garments to children with hypohidrotic ectodermal dysplasia (HED), multiple sclerosis, spina bifida, cerebral palsy and other genetic disorders. HED is a medical disorder characterized by a lack of sweat glands, which can lead to heat exhaustion, heatstroke and even death. Thirty children are on the foundation's waiting list for a suit like Mikie's.

MicroClimate Systems, Inc., of Sanford, Michigan, supplied the phase change vest, and the Solar Protective Factory of Carmichael, California, provided the ultraviolet protective outer garments. The DRLI Company, St. Charles, Missouri, which supplies protective coatings for astronauts' spacesuit helmets, supplied the clear ultraviolet-blocking coating for Mikie's ski-goggle-like face visor. ✱

For more information, contact John Ira Petty at Johnson Space Center. ☎ 281/483-5111, ✉ [john.i.petty@jsc.nasa.gov](mailto:john.i.petty@jsc.nasa.gov) Please mention you read about it in *Innovation*.

# Remote Sensing Takes to the Road

**P**LANNING TIME NEEDED FOR HIGHWAY construction could be significantly reduced and at the same time enhance route quality by applying remote sensing. This could be accomplished with sensors mounted on aircraft or satellites for observing Earth's surface, providing images to make detailed maps of selected study areas.

NASA's Stennis Space Center recently applied its comprehensive commercial remote-sensing capabilities to highway routing plans for the Mississippi Department of Transportation (MDOT). The remotely sensed images gathered for the MDOT project were used to form a highly accurate, digital map data base to determine the best route for a highway—a connecting route between Hernando, Mississippi, and Collierville, Tennessee—that is still being planned. By having a synoptic view of a proposed route, planners can determine what transportation infrastructure, buildings, industrial facilities, water bodies, farmlands, forests, wetlands and geological features are present.

In October 1997, MDOT supervisors viewed a demonstration at Stennis of possible transportation applications of remote sensing. After a meeting with MDOT engineers, a team at Stennis transformed

*In September 1997, two boys in England with a serious light allergy were given a protective suit prototype that has since been modified for others with light-sensitivity disorders.*





MDOT's requirements into data sets for integration into a geographic information system (GIS) prototype to help select the optimal highway route.

The model became an analysis and visualization tool for the 20-mile-by-5-mile area under consideration. The model contained layers of criteria that influence route planning: utility corridors, civic structures, natural deposits, water bodies, flood zones, homes and businesses, wetlands and farmlands.

Preliminary transportation planning using a computer model reduces time, but it will not replace people in the field who have to conduct highly accurate field data. Remote sensing does support field crews. A project once requiring a year could now take as little as a few months.

"Transportation projects using this technology will be implemented more quickly at less cost to the public. Use of remote sensing also can balance environmental and other considerations that can cause enormous delays to a project," said Tom Stanley of the Commercial Remote Sensing Program at Stennis. ✱

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For more information, contact Bob Collins at Stennis Space Center.

✉ [Robert.Collins@ssc.nasa.gov](mailto:Robert.Collins@ssc.nasa.gov) Or contact Lanee Cooksey at Stennis.

☎ 228/688-1957, 📠 228/688-1094, ✉ [Lanee.Cooksey@ssc.nasa.gov](mailto:Lanee.Cooksey@ssc.nasa.gov)

Please mention you read about it in *Innovation*.

## Space Crystals Provide Hope for Diabetes

**D**IABETIC PATIENTS MAY SOMEDAY REDUCE their insulin injections and lead more normal lives because of new insights gained through innovative space research in which the largest insulin crystals ever studied were grown on the Space Shuttle. The results from a 1994 insulin crystal growth experiment in space are leading to a new understanding of diabetes, a hormone deficiency disease.

These results have the potential to significantly reduce expensive treatments; the treatment of diabetes accounts for one-seventh of the nation's health care costs. Sixteen million Americans suffer from hormone deficiency diseases, such as diabetes, hepatic failure, hemophilia, Parkinson's disease and Huntington disease.

"The space-grown insulin crystals have provided us new, never-before-seen information," said Dr. G. David Smith, a scientist at Hauptman-Woodward Medical Research Institute in Buffalo, New York. "As a result, we now have a much more detailed picture of insulin."

Because of the increase in crystal size, Smith's team is able to study in more detail the delicate balance of the insulin molecule. Natural insulin molecules hold together and gradually release into the human body. With some of the new and unexpected findings, researchers may be able to improve how insulin is released from its inactive-stored state to its active state. This could greatly improve the quality of life of people on insulin therapy by cutting down on the number of injections they have to take.

Hauptman-Woodward is partnering with the Center for Macromolecular Crystallography (CMC), a NASA Commercial Space Center in Birmingham, Alabama, managed by the Space Product Development Office within the Microgravity Research Program Office at Marshall Space Flight Center in Huntsville, Alabama. "We are doing crystal growth experiments in the near weightlessness of space that really tell the story of how insulin works and give us clues of how, in the long run, to defeat diabetes," said Dr. Marianna M. Long, Associate Director of CMC, which is located at the University of Alabama at Birmingham.

Insulin regulates the human body's blood sugar levels. In people with diabetes, insulin is not produced in sufficient quantity, nor regulated properly. This metabolic disorder impairs the body's ability to use digested food for growth and energy.

As with many chemicals in the body, the three-dimensional structure of insulin is extremely complex. The intricate, blueprint-like arrangement of atoms within the insulin molecule determines how well the hormone interacts within the body. When grown in an Earth-gravity environment, insulin crystals do not grow as large or as ordered as researchers desire, obscuring the blueprint of the insulin molecules.

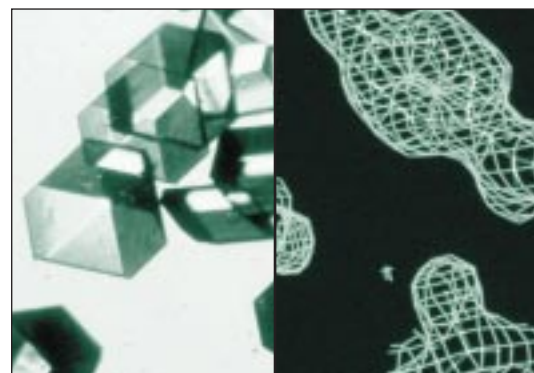
The crystals are grown in space because the absence of gravity allows large and perfect crystalline structures to form. Structure-based drug design shortens development time over the classic trial-and-error method of drug testing. This structural information is a powerful research tool for drug design in the pharmaceutical, chemical and biotechnology industries. ✱

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For more information, contact Steve Lambing at the Marshall Space Flight Center.

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Please mention you read about it in *Innovation*.



(Left)  
*The largest insulin crystals ever studied and grown in space have provided new, never-before-seen information to help treat diabetes.*

(Right)  
*Space-grown insulin crystals reveal the blueprint of the insulin molecules normally obscured if grown in an Earth-gravity environment.*

# Technology Keeps an Eye on Intersections

**A** NEW TRAFFIC TECHNOLOGY VISUAL DISPLAY at intersections can warn motorists quickly of rapidly approaching emergency vehicles and trains. The Emergency Vehicle Early Warning Safety System (E-VIEWS) equips emergency vehicles with transponders that communicate via microwave with receivers on large visual displays deployed on the mastarms above the centers of intersections.



*Transponders in emergency vehicles communicate via microwave with receivers on large visual displays at traffic intersections to warn of their approach.*

## SOFTWARE AWARD WINNERS SHOW COMMERCIAL PROMISE

**T**wo computer programs selected as 1998 NASA Software of the Year award winners are expected to open up promising commercial applications. One program, which is designed to control air traffic, is expected to substantially save costs for airlines and passengers. The other award-winning software, which will use the Internet for remotely controlling International Space Station (ISS) experiments, is expected to spawn several new commercial markets.

NASA will grant the awards at this year's Technology 2008 Conference in Boston, Massachusetts, November 3 through 5. The awards are given annually to NASA-developed software that has significantly enhanced the Agency's performance of its mission and helped American industry maintain its world-class technology status.

Tempest, a program originally developed to support the science experiments on the ISS, is considered to be breakthrough and enabling technology likely to develop commercial markets for web-embedded remote control mechanisms, especially in the automotive, consumer electronics, office products and medical industries, according to a study performed for NASA. The commercial quality software is fully documented; it installs simply and uses standard World Wide Web browsers to let users operate the experiments. Tempest was written by Maria Babula, Lisa Lambert, Joseph Ponyik and David York of NASA's Lewis Research Center in Cleveland, Ohio, and Richard A. Tyo of Intel Corporation.

The second winner, Center TRACON Automation System Software, is a set of three software tools for managing air traffic control systems by optimizing flight operations at major airports. It is expected to save an average of two minutes per flight, in turn saving money for the airlines and passengers. The Federal Aviation Administration has chosen the software for immediate implementation into all major airports, saving as much as \$800 million annually. It has been integrated into the existing radar system at the Dallas/Ft. Worth airport. Software displays in the control room supplement the manual air traffic control system. Written by Michelle Eshow and a team of 37 others at NASA's Ames Research Center, Moffett Field, California, the software analyzes and predicts aircraft paths, creates visual representations of the flow of arriving traffic and provides controllers up-to-the-second advisories of information to pass on to pilots. This will reduce the time between landings to the minimum possible. ✱

For more information, contact Brian Dunbar at NASA Headquarters. ☎ 202/358-0873, 📠 202/358-4210, ✉ [bdunbar@mail.hq.nasa.gov](mailto:bdunbar@mail.hq.nasa.gov) Please mention you read about it in *Innovation*.

As the vehicles approach the intersections, signal lights turn yellow, then red, for cross traffic, and approaching drivers also view flashing vehicle symbols on the visual displays. These active displays, linked to the receivers, inform drivers of the direction emergency traffic is approaching or departing the intersection. The vehicle symbols seem to move across the displays, synchronized with the actual emergency vehicles' movements.

"More than 156,000 accidents involving emergency vehicles occurred at intersections in U.S. cities from the mid-1980s to 1995 alone," explained Jim Davidson, president and CEO of the company that developed the system, E-Lite Limited of Agoura Hills, California. "Emergency vehicles present a serious traffic hazard to themselves, other vehicles and pedestrians while passing against cross traffic through an intersection, causing multimillion-dollar lawsuits against cities and states," he added.

Davidson, a former marketing executive, has firsthand experience with the dangers of high-speed vehicles. He was driving his car when it was almost hit broadside by a fire truck at a Los Angeles intersection.

Davidson contacted the Technology Affiliates Program at the Jet Propulsion Laboratory (JPL). He was paired with JPL engineers with specialized expertise in solving engineering design issues. These included not only the customized transponders of E-VIEWS, but also comprehensive designs that blend with existing city communications infrastructures. E-VIEWS is now being further refined with an eye toward the installation of demonstration models in large metropolitan areas. ✱

For more information, contact Alice Wessen at JPL. ☎ 818/354-4930, 📠 818/393-4093, ✉ [alice.s.wessen@jpl.nasa.gov](mailto:alice.s.wessen@jpl.nasa.gov) Please mention you read about it in *Innovation*.



# ADVANCED TECHNOLOGIES

## Underwater Facility Is Commercially Afloat

**N**ASA IS NEGOTIATING AN AGREEMENT FOR a Houston, Texas, firm to operate the deactivated Neutral Buoyancy Simulator facility at the Marshall Space Flight Center. The purpose of the facility is to provide a unique, controlled simulation environment for underwater research, development and training for commercial applications.

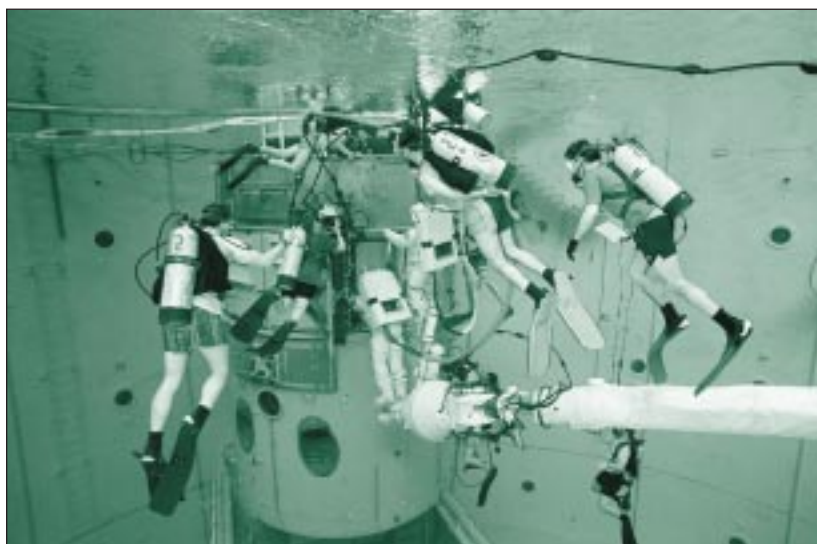
The firm, Oceaneering Space Systems, is an advanced applied technology company that provides engineering services and hardware to customers who operate in marine, space and other harsh environments. Oceaneering's services and products are often combined to offer complete project solutions and are marketed worldwide to oil and gas companies, government agencies and firms in the telecommunications, aerospace and civil engineering, and construction industries.

The question of commercial viability of the facility—a 75-foot-diameter, 40-foot-deep water tank that holds 1.3 million gallons of water—had been raised prior to and since its July 1, 1997, closing. NASA's requirements are now accommodated at a new, larger tank at the Johnson Space Center in Houston.

From 1968 to 1997, NASA performed a wide range of operations in the facility to develop, test and refine techniques and hardware for use in space. The facility provided NASA engineers, scientists and astronauts the closest simulation available on Earth of the low-gravity environment of space. By attaching a system of floats and lead weights to people and objects, engineers simulated weightlessness by making a subject "neutrally buoyant"—neither sinking nor floating.

The Neutral Buoyancy Simulator facility has supported a number of successful space missions. It was designated a National Historic Landmark in 1985, in recognition of its important role in support of the U.S. space program. The simulator was used to evaluate techniques for assembling the International Space Station and to test the Hubble Space Telescope. It also helped in developing procedures that saved Skylab after the spacecraft suffered damage to its sunshield during launch in 1973.

In response to a congressional and Agency request, Marshall issued an announcement seeking



industry commercialization plans in December 1997. The agreement calls for the facility to operate at no cost to the government. ✱

For more information, contact Rip Nabors at Marshall Space Flight Center.  
☎ 256/544-0688, ☎ 256/544-3151, ✉ [william.h.nabors@msfc.nasa.gov](mailto:william.h.nabors@msfc.nasa.gov) Please mention you read about it in *Innovation*.

*Now deactivated, Marshall's Neutral Buoyancy Simulator, used to prepare for on-orbit Hubble Space Telescope operations, is being set up for commercial use.*

## The Door Opens Wider for Dual Use

**A**N EXCLUSIVE LICENSE HAS BEEN GRANTED to a New Jersey company to further develop more commercial applications and wider uses for one of NASA's most widely adopted "spinoff" technologies—the power factor controller. This device is used in countless homes and businesses today as a means for efficient electrical energy conservation.

"Initially, more than 20 companies sought and were granted nonexclusive licenses for commercial use of the invention," said Bob Broad, chief intellectual property counsel at Marshall Space Flight Center. "NASA believes Power Efficiency Corp., one of the first companies to hold a nonexclusive license agreement, has distinguished itself and demonstrated the commitment necessary to develop the technology further."

An exclusive licensing agreement signed between NASA and Power Efficiency Corporation of Hackensack, New Jersey, could make wider use and further conservation of scarce energy resources possible.

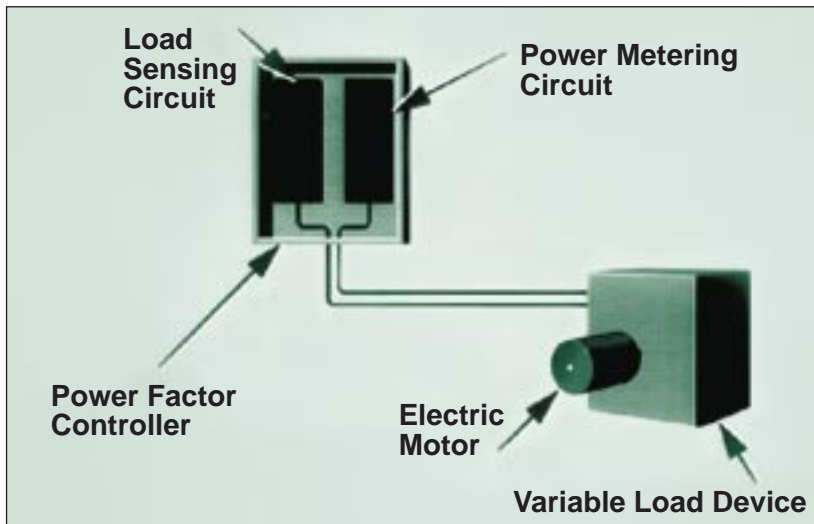


Diagram shows how circuit and motor components interface with power factor controller device.

The power factor controller senses the amount of power needed by an electric motor. The device then varies the power according to the need. Laboratory tests show the controller can trim power usage by 6 to 8 percent under normal demand conditions and by as much as 65 percent when a motor is idling.

Invented by now-retired NASA engineer Frank Nola for the space program in the early 1980s at NASA's Marshall Space Flight Center in Huntsville, Alabama, the power factor controller, with its remarkable potential for energy savings, quickly became one of NASA's most widely adopted "spinoff" technologies. It was incorporated into machines ranging from household refrigerators and washing machines to typewriters, kidney dialysis and industrial drilling machines, as well as scores of other commercial products.

Nicholas Anderson, president of Power Efficiency Corp., said, "Our success in marketing our energy-saving motor controllers is directly attributed to the relationship developed over the years between Power Efficiency Corp. and NASA. This relationship proves that great benefits can occur when individuals and government work together to develop technologies that reduce energy consumption."

Under the terms of the agreement, Power Efficiency will pay royalties to NASA and inventor Frank Nola until 2001, when the patent and the exclusive licensing agreement expire. ✱

For more information, contact Bob Lessels at Marshall Space Flight Center.

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Please mention you read about it in *Innovation*.

## NASA Tries Hair-Raising Idea

RESEARCHERS AT NASA'S MARSHALL SPACE Flight Center in Huntsville are testing an Alabama hairdresser's hair-raising technique of using human hair to soak up oil spills. This could lead to a number of applications, including reducing landfill waste, saving costs in oil spill cleanups and recovering spilled oil for fuel.

Madison, Alabama, hairdresser Phillip McCrory was watching television coverage of 1989's oil spill in Alaska's Prince William Sound. He saw the oil-saturated fur of a sea otter and asked himself, "If animal fur can trap and hold spilled oil, why can't human hair?" He conducted a home experiment using five pounds of human hair he had cut, collected and stuffed into a pair of his wife's pantyhose tied into a ring. He filled his son's wading pool with water, put the hair-filled hosiery ring into the center of the pool and poured used motor oil into the middle.

McCrory found that human hair adsorbs—rather than absorbs—oil. That is, instead of bonding with the hair, the oil gathers in layers on the hair's surface, allowing for easy recovery and reuse of the oil by simply squeezing it from the collection bundles.

McCrory researched and made sure his solution was unique. He found patents similar to his idea that involved using sheep's wool and duck feathers for in-demand items such as clothing and insulation, but they do not adsorb as well as human hair.

"Human hair thousands of years old has been found in landfills, and tons of human hair cut every day are tossed into landfills," McCrory said. Using the hair to clean up oil spills would both put it to work and reduce the amount of waste material going into landfills, he believes. Oil-saturated bundles of hair can be burned as fuel, and the energy value contained in the collection bundles can be recovered.

Researchers at Marshall agreed to test McCrory's idea under controlled laboratory conditions for potential use by NASA and other U.S. government agencies. Successful preliminary field tests also influenced Marshall's decision to test McCrory's system further.

In an initial test, David Glover, a chemical systems supervisor for Marshall contractor BAMSI, Inc., filled a 55-gallon oil drum with 40 gallons of water and 15 gallons of oil. "The mixture was filtered through nylon bags filled with hair," said Glover. "When the water was tested after just a single pass through McCrory's innovative filter, only 17 parts of oil per million parts of water remained."

McCrory estimates that 25,000 pounds of hair in nylon collection bags may be sufficient to adsorb 170,000 gallons of spilled oil. Preliminary tests show that a gallon of oil can be adsorbed in

less than two minutes with McCrory's method.

There is also a potential cost savings in McCrory's method. Present oil cleanup methods cost approximately \$10 to recover a gallon of oil. McCrory's system may cost as little as \$2 per gallon and offers the additional benefit of being able to use the recovered oil for fuel. McCrory has founded and is president of his own company, BEPS Inc. of Madison, Alabama. ✱

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For more information, contact Liz Rodgers at Marshall Space Flight Center.

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## THE HUBBLE OF THE NEW MILLENNIUM

The Hubble Space Telescope has advanced our understanding of the universe as well as the quality of health, safety and life on Earth through a variety of technological spinoffs. The Space Telescope Science Institute at Johns Hopkins University in Baltimore, Maryland, operates the Hubble and has been selected to manage science operations for the Next Generation Space Telescope (NGST), Hubble's critical follow-on project to continue delivering world-class optical and infrared science well into the new millennium. NGST will perform observations of the first stars and galaxies to help understand their formation after the Big Bang.

"It became apparent that the most cost-effective and scientifically sound way to proceed was to expand the Institute's responsibilities to include the management of NGST," said Dr. Wesley T. Huntress, Jr., Associate Administrator for NASA's Office of Space Science at NASA Headquarters in Washington, D.C. "We can now count on at least a seven-year continuation of their outstanding efforts, rather than closing the doors to the facility after the Hubble mission ends in 2010," he added.

NGST will have capabilities currently unavailable in existing ground-based or space telescopes. The Hubble's Charged Coupled Device (CCD) technology, silicon chips that convert light directly into electronic or digital images, has produced successful commercial applications, including:

- Digital Breast Imaging—Noninvasive and nonsurgical breast biopsy systems give more clear and efficient breast imaging, saving women time, pain, scarring, radiation exposure and money.
- Computer Generated Holograms—The extremely precise mirrors that corrected Hubble's vision were tested by the same holograms that test microprocessor chips for the production of smaller and more densely packed computer chips.
- Omniview Imaging System—Image correction and microprocessing provide an undistorted, real-time, flat-view image from anywhere in a hemispherical field, for use in security and surveillance, teleconferencing, imaging, broadcasting and military operations.
- Traffic Monitoring—Sensors view traffic activity and produce optional still and video images.

With Hubble, NASA learned the importance of involving scientists early in the major mission science and operations planning.

Studies are under way, and NGST's formal development is expected in 2003, with a projected launch in 2007, an operational lifetime of ten years and expected operating costs from \$15 million to \$25 million per year. ✱

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For more information, contact Bernard Seery at Goddard Space Flight Center. ☎ 301/286-5712, ✉ [Bernard.D.Seery@gsfc.nasa.gov](mailto:Bernard.D.Seery@gsfc.nasa.gov) Please mention you read about it in [Innovation](#).



# AEROSPACE TECHNOLOGY DEVELOPMENT

## X-33 Shields Take the Heat

NASA'S F-15B AERODYNAMIC FLIGHT FACILITY aircraft has successfully completed flight testing of Thermal Protection System (TPS) materials, or heat shields, to be used for the X-33 Advanced Technology Demonstrator at NASA's Dryden Flight Research Center, Edwards, California.

Thermal protection systems perform in temperature ranges from minus 250 degrees Fahrenheit in the cold soak of space to entry temperatures that reach nearly 3,000 degree Fahrenheit. They are used on spacecraft to protect them during flight, primarily as a "heat shield" during reentry into Earth's atmosphere. Although the X-33 is a suborbital technology demonstrator, it will encounter an extreme heating environment similar to what such a vehicle will encounter during orbital space flight and atmospheric reentry.

Scheduled to begin test flights in July 1999, the wedge-shaped X-33 is one of three demonstration prototypes of the Reusable Launch Vehicle (RLV) program, leading to the next generation of commercially developed and operated single-stage-to-orbit vehicles. The overall goal for the RLV program is to reduce the cost of access to space and putting payloads in space, as well as to promote the creation and delivery of new space services and other activities that will improve and increase U.S. economic competitiveness.

"This is an excellent example of all the testing the X-33 program is performing on the challenging technologies we need for a reusable launch vehicle," said Dan Dumbacher, NASA's X-33 deputy program manager.

The TPS material samples include metallic Inconel tiles, soft Advanced Flexible Reusable Surface Insulation tiles and sealing materials. They were flown attached to the forward-left side position of the F-15B's

Flight Test Fixture II, a device attached underneath the aircraft to carry experiments. In-flight video from the aircraft's on-board video system, chase aircraft photographs and video cameras documented the condition of the TPS materials during flights.

The F-15B reached an altitude of 36,000 feet and a top speed of Mach 1.4

during the series of six flights at velocities above the speed of sound. No damage or signs of wear from high speed or maneuvering were apparent on any of the TPS materials. This provided the X-33 team more information about the stability of the materials to successfully protect the X-33 and follow-on vehicles in the harsh environment in which they will fly.

TPS materials can be applied commercially to situations and structures subjected singly or repeatedly to high heat fluxes. Such applications include firefighting equipment, insulation materials, the automotive industry for engines, industrial and manufacturing machinery, roof coatings in high fire-danger areas, safes and safety deposit boxes, and electrical wiring, hoses or pipes carrying volatile materials.

Private industry will build and operate the RLV in the first decade of the next century, and NASA will be a customer. The program has implemented the National Space Transportation Policy, issued by the White House in 1994, and will accelerate the development of new launch technologies and concepts to contribute to the continuing commercialization of the national space launch industry. ✱

For more information, contact David Richwine at Dryden Flight Research Center.

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## Radar System Vital to Cloud Study

NASA'S AIRBORNE CLOUD RADAR HAS BEEN IN the sky aboard a NASA DC-8 in an effort to better understand clouds—how they affect our environment and our quality of life. This Airborne Cloud Radar flight series, expected to total 20 flight hours, is designed to test several hypotheses and techniques related to satellite remote sensing of extensive, long-lasting, non-precipitating layers of cloud in the middle and upper troposphere up to seven miles from Earth's surface.

Cloud studies provide scientists the most detailed information to date on the processes of powerful storms, leading to new insights on how they affect global climate patterns and to improved forecasting that saves lives and money. Studying cloud structures can help in forecasting global climate patterns, not just in the near future but in many years ahead. This will prove beneficial in predicting floods, droughts or above- or below-

*Heat shields successfully protected the X-33 prototype in recent tests, demonstrating how the vehicle will handle extreme environments when flying as part of the commercially developed and operated Reusable Launch Vehicle program of the future.*



average temperatures. All of these can have positive effects on the quality of life on Earth—rendering potential life savings, preventing cost increases, maintaining productivity and avoiding a negative economic effect. It can translate into stock pile upkeep, city planning, staff advanced planning and sport and entertainment activity schedules.

“Clouds represent a scientific puzzle that researchers have been trying to piece together for centuries,” said Dr. Fuk Li, the principal investigator for the cloud radar at NASA’s Jet Propulsion Laboratory in Pasadena, California. “Scientists still don’t know very much about the internal, vertical structures of clouds, and that leads to uncertainties in weather and climate predictions,” he said. “Using the cloud radar, we will be able to study clouds in a new way that will help us understand their structure like never before. Once we have the cloud vertical structure information, atmospheric scientists will have a much better handle on long-term predictions of weather and climate change.”

Scientists will compare these data with measurements taken by satellite and ground-based sensors, including the Department of Energy’s Southern Great Plains Cloud and Radiation Testbed. Known by the acronym CART, this testbed is a series of instruments spread across north central Oklahoma and south central Kansas.

The cloud radar experiment was installed in the tail area (looking downward) of the DC-8 at NASA’s Dryden Flight Research Center in Edwards, California. The DC-8 then flew to Tinker Air Force Base near Oklahoma City, Oklahoma, the origination point of this series of missions in which the radar collects cloud data while the plane flies above the clouds. The radar, taking vertical measurements of the clouds

## SPACE NETWORK COMMUNICATIONS ENHANCED

A new ground terminal, managed by Goddard Space Flight Center, was opened in July, on Guam, to provide global, full-time and real-time communications support for NASA’s Space Network customers, including the Space Shuttle, the International Space Station and the Hubble Space Telescope. The new terminal communicates with a geosynchronous tracking and data relay satellite stationed out of view of the existing Space Network ground stations located in White Sands, New Mexico.

“NASA built the Guam ground station to significantly expand the quantity and quality of services we provide to all our customers,” said Goddard’s ground terminal project manager, Tom Gitlin. The terminal adds to NASA’s vital communications and data-gathering network in support of NASA’s Earth-orbiting missions.

The Guam Remote Ground Terminal was conceived after NASA’s Compton Gamma Ray Observatory suffered an onboard tape recorder failure in March 1992 so it required full-time, real-time communications support. NASA established a limited capability ground terminal in Canberra, Australia, in late 1993 to provide continued support for the observatory’s science mission. Goddard project officials quickly realized that an enhanced ground station was needed in the Pacific to better serve NASA’s Space Network’s coverage over the Indian Ocean. ✱

For more information, contact Tom Gitlin at Goddard Space Flight Center.

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Please mention you read about it in *Innovation*.



*Construction of the white protective dome that houses NASA’s Guam Remote Ground Terminal’s satellite dish, which provides multiple-mission capability for current and future tracking and data relay satellites.*

from above, operates at 94 gigahertz, making it sensitive to cloud particles. The instrument transmits radar energy, which bounces off the cloud particles and is reflected back toward the aircraft. The radar measurements will be combined with information provided by other sensors to help analyze the properties of the clouds observed.

“The DC-8 was selected because it is the only aircraft that is capable of this mission in terms of altitude, speed, range and capacity for carrying scientists onboard. Since scientists can fly on the aircraft, they can operate their experiments themselves,” said DC-8 mission manager Chris Jennison of Dryden.

The Jet Propulsion Laboratory developed the Airborne Cloud Radar in conjunction with the University of Massachusetts at Amherst; Colorado State University in Ft. Collins; and the University of Pennsylvania in Philadelphia. ✱

For more information, contact Dr. Fuk Li at the Jet Propulsion Laboratory.

✉ [Fuk.Li@jpl.nasa.gov](mailto:Fuk.Li@jpl.nasa.gov) Please mention you read about it in *Innovation*.

## Earth's Smoke Viewed From Space

**N**ASA RESEARCHERS CLOSELY MONITORED this year's fires in Mexico, using the unique perspective of space, to see how smoke from natural and human-induced fires contribute to global air pollution and climate changes. Since the beginning of the Mexican fires in late March and early April of this year, NASA atmospheric researchers used the Total Ozone Mapping Spectrometer (TOMS) to observe the smoke aerosols emitted by the fires.

The TOMS instrument has the ability to obtain daily images of the amount of smoke present in any atmospheric conditions anywhere in the world. TOMS makes 35 measurements every eight seconds, each covering 30 to 125 miles wide, from Earth's surface to the atmosphere's top.

Fires such as those in Mexico interest scientists because smoke contributes to the overall regional air pollution levels that can impact the quality of air that humans breathe, especially those with asthma. Increased smoke concentration from human-induced fires could contribute to global climate change.

The current NASA-developed TOMS instrument is a second-generation backscatter ultraviolet ozone sounder. It measures ozone indirectly by comparing ultraviolet light emitted by the Sun to that scattered from Earth's atmosphere back to the satellite at six wavelengths. Backscattered radiation is solar radiation that has penetrated Earth's lower atmosphere and is then scattered by air molecules and clouds back through the stratosphere to the satellite sensors. Along that path, a fraction of the ultraviolet is absorbed by ozone.

By comparing the amount of backscattered radiation to observations of incoming solar energy at identical wavelengths, scientists can calculate Earth's albedo, the ratio of light reflected by Earth compared to that which it receives. Changes in albedo at the selected wave-

lengths can be used to derive the amount of ozone above the surface.

The fires started in southern Mexico and northern Guatemala near the end of March 1998. Some fires were started as part of the annual clearing of agricultural fields; others started naturally with lightning because of the extremely dry conditions.

The small particles, called aerosols, can affect the amount of energy reaching Earth's surface by reflecting and/or absorbing sunlight. Smoke aerosols also can act as small particles on which clouds can form. Clouds containing smoke aerosols are believed to reflect and absorb energy in different ways than clouds formed from natural particles, such as dust or sea salt.

"Shortly after the fires started, we noticed the huge increase in the amount of aerosols (in this case smoke) in the region," said Dr. Jay R. Herman, an atmospheric scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Large amounts of smoke extended into Florida, Texas, New Mexico, California and Wisconsin. On May 16, the smoke plume extended across the eastern United States, passing through Ohio and into southern Canada.

Because of the difficulties in extinguishing the fires, some large smoke plumes are lingering in Mexico. The smoke tends to extend from the ground up to an altitude of about three to four kilometers (1.8 miles) and to follow the prevailing winds. Because of wind shear in this altitude range, there is frequently more than one plume, with smoke blowing from west to east and from south to north.

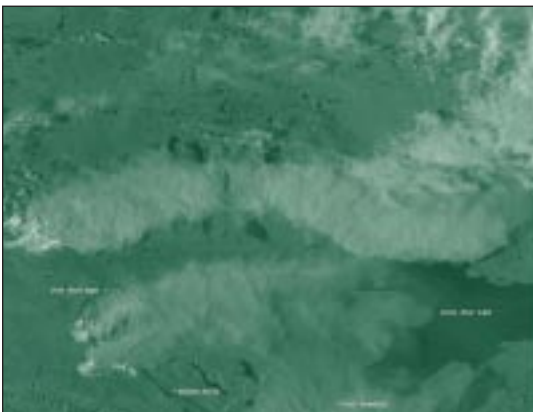
The fires and accompanying smoke lasted through the middle of June, when rain finally relieved the drought conditions associated with El Niño weather patterns. Since then, there have been major fires observed in Russia and South America, as well as extraordinary amounts of Saharan dust blowing across the Atlantic into the Caribbean and across the southern United States and Mexico.

TOMS is part of NASA's Earth Science Enterprise, a long-term, coordinated research effort to study Earth as a global system. The TOMS program is managed by the Goddard Space Flight Center for NASA's Office of Earth Science in Washington, D.C. ✱

For more information, contact Dr. Jay R. Herman at Goddard Space Flight Center.

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*Using the TOMS instrument, scientists can obtain images of atmospheric smoke present anywhere in the world. Increased smoke contributes to global climate change.*





# SMALL BUSINESS/SBIR

## Potential for Paperless Payload Processing

**A**N ALEXANDRIA, VIRGINIA, COMPANY IS commercializing a paperless procedures system it developed under a Kennedy Space Center Small Business Innovative Research (SBIR) contract for use in Space Shuttle and International Space Station payload processing operations. SENTEL Corporation will offer the Advanced Process Manager™ (APM), a state-of-the-art system for executing maintenance and inspection procedures within a robust product data management system framework.

The aerospace system life cycle data management is the primary focus, with defense system life cycle data management, product data management, supply chain management and fleet maintenance management to follow. The APM combines NASA's Electronic Portable Information Collection (EPIC) System with leading configuration and data management tools—CMstat's V5 configuration management software and Symbol Technologies' Spectrum 24™ wireless network technology.

EPIC incorporates a handheld, pen-based computer platform with the capability to install a variety of data collection forms, record data against those forms, imprint controlled signature authority, maintain the integrity of the data collected and relay the data to a computer network for analysis or archiving. Data are entered electronically, either with a keyboard or a pen, using handwriting recognition. The system distributes these data to all other terminals. The ink stamp is replaced with an electronic stamp that meets the form, fit and function of the old ink stamp. A programmable memory chip inside the electronic stamp stores a unique identifier. Once the procedure is completed, it is converted to Portable Document Format (PDF) and stored electronically in a documentation system.

NASA and SENTEL designed, built and tested the prototype, determined it to be a viable option and formed a partnership through a Nonreimbursable Space Act Agreement to develop the operational version of the system. NASA developed EPIC's form conversion, stamp utilities and report generator software, which are applications that are more specific to requirements for use in the Space



*Space Shuttle payload processing operations combined with a promising Portable Data Terminal software module are being commercialized into a state-of-the-art paperless data management system with numerous applications.*

Shuttle Main Engine Shop and for Space Station ground processing in 1998.

NASA and United Space Alliance (USA), the Space Shuttle launch contractor at Kennedy Space Center, are planning a pilot program for using EPIC at the Hypergol Maintenance Facility. Also, Kennedy and Ames Research Center are conducting research to apply the EPIC project in the area of wireless communication and in developing smaller, lighter hardware to display the EPIC portable data terminals in various Kennedy environments, NASA Lead Project Engineer Darcy Miller said.

SENTEL is responsible for developing the Portable Data Terminal software module. This piece of software holds the greatest potential in other work environments, such as the aerospace and aviation (airline) industries, the warehouse and shipping industries, the shipbuilding industry, law enforcement agencies and public utilities. Other potential applications include maintenance workflow management, inventory, inspections, electronic document management and ISO 9000 certification.

For example, SENTEL is working with the electrical power industry to study the development of an EPIC-based system for electrical power substation maintenance and is scheduling installs in select power plants. In addition, a major European airline is negotiating with SENTEL for an EPIC-based airplane maintenance system. ✱

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For more information, contact the Technology Programs and Commercialization Office at Kennedy Space Center. ☎ 407/867-6380. Or contact Kevin L. Jackson at SENTEL. ☎ 703/739-0084, 📠 703/739-6028, ✉ [kjackson@sentel.com](mailto:kjackson@sentel.com) Please mention you read about it in *Innovation*.

## Research Unearths New Vegetation Science

**A** SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) contract between NASA and Boulder Innovative Technologies (BIT), a Colorado company, has spawned a new science called zeponics, which offers numerous commercial applications using a superior plant nutrition system. Research using zeolite, a naturally occurring group of more than 50 minerals, is expected to be directly applied in the International Space Station and future Advanced Life Support missions to extraterrestrial bodies, such as Mars and the Moon.

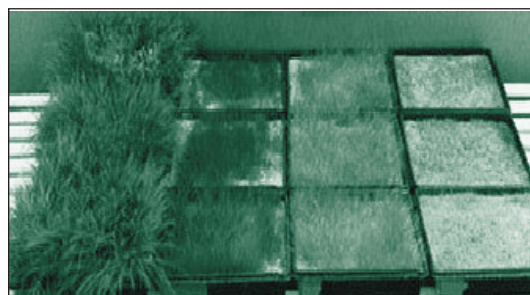
ZeoponiX, Inc., of Louisville, Colorado, is a BIT spinoff company that holds exclusive rights to this patented zeoponic technology. The company is manufacturing ZeoPro™, a combination of a nutrient-charged zeolite and slowly dissolving substances that contain phosphorus and other nutrients. ZeoPro™ delivers nutrients in a plant demand-driven fashion. The product also offers superior water retention and lower leaching levels.

Zeolite can be adapted for a variety of uses, but a major application is plant nutrition. Made of a special crystalline structure that is porous, zeolite remains rigid in the presence of water.

“Rather than [humankind] trying to second-guess the exact timing of nutrient needs for the plant, with zeponics, the plant does the regulating of the nutrients as it needs them,” explained ZeoponiX Chief Executive Officer Richard D. Andrews. “With only the addition of water, plants will grow in the zeoponic medium for multiple growth cycles.”

Plants are considered critical to prolonged space exploration, supporting astronauts with water, oxygen and food and helping recycle waste products as part of a regenerative life support system. NASA scientists at Kennedy and Johnson Space Centers have been studying ways to sustain plant growth in space environments. Zeolite helped solve the problem of an efficient hydroponic system, and the word “zeponics” was created.

The initial market of turf—golf greens and specialty playing fields—has expanded to include agriculture and many types of horticulture, such as commercial greenhouses for floriculture, vegetable horticulture and environmental horticulture (nurseries, tree farms and so on), according to Andrews



*Plant sustenance research has generated a new science that offers several applications for a plant nutrition system with many benefits. This system greatly reduces nutrient release and loss into ground water and runoff.*

and ZeoponiX President James W. Shaw. Consumer zeoponic products will include specialty fertilizers and growth mediums, as well as potting mix blends.

“The product is technically innovative, and specifically formulated products are being designed to serve the targeted markets,” Shaw said. Distributorship arrangements have been established in many U.S. geographic areas and abroad.

The products are environmentally friendly and greatly reduce the release and loss of nutrients into ground water and runoff. This results in lower overall nutrients applied to achieve equal or superior plant growth and performance. A growing awareness and increasing environmental regulations are focusing on the overuse of fertilizers and the negative impacts on the environment. Zeponics can help alleviate this problem. ✱

For more information, contact Richard D. Andrews at ZeoponiX.

📞 303/673-0098, ✉ [rdajws@zeoponix.com](mailto:rdajws@zeoponix.com) Or contact James W. Shaw at ZeoponiX. 📞 303/673-0098, ✉ [0098rdajws@zeoponix.com](mailto:0098rdajws@zeoponix.com)

Please mention you read about it in *Innovation*.

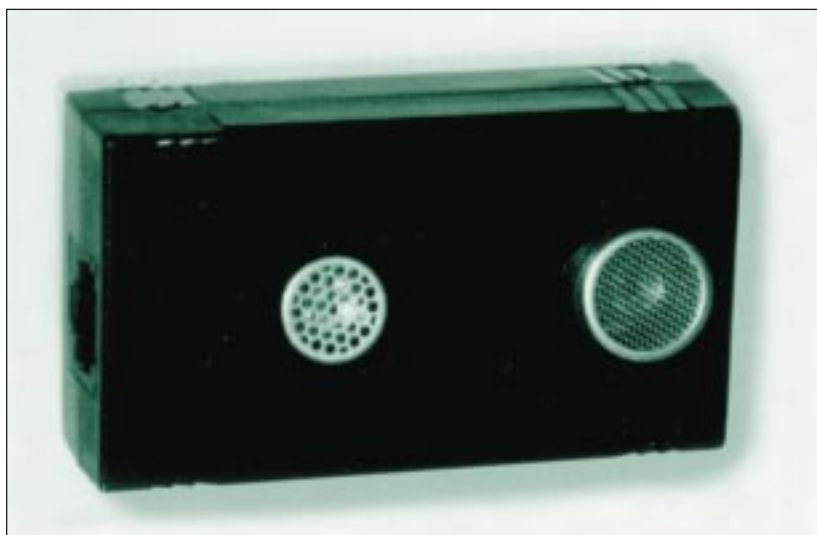
## Finding Parking No Guessing Game

**A**DVANCED SENSOR TECHNOLOGY DESIGNED to improve robotic operations at NASA's Kennedy Space Center could help motorists find a parking spot on their own and keep garage operators and others from losing income in a number of parking settings, including busy airports, theme parks and parking garages. The Parking Garage

Automation System (PGAS), a result of a Small Business Innovation Research (SBIR) contract, is a sensor system that could autonomously guide motorists to open facilities and, once within, to free parking spaces. At the same time, it could log license plate numbers for security measures.

The PGAS is based on a technology called Robot Sensor Skin that contains smartSensor™ modules and flexible printed circuit board skin to help robots steer clear of obstacles using a proximity sensing system. The smartSensor™ technology is the result of work by SBIR contractor Merritt Systems, Inc., of Orlando, Florida, to improve robots working with critical flight hardware and to provide a redundant collision avoidance safety system.

Garage operators would not lose the estimated \$10 to \$15 per car per day when they close parking levels, thinking they are at full capacity. When they



*Commercial application of an advanced sensor technology used for preflight Shuttle payload inspection and verification may be used to guide motorists directly to parking spaces.*

## SMALL BUSINESS GETS A BIG JOB

**L**B&B Associates, Inc., of Columbia, Maryland, a small, minority, woman-owned business, has been awarded a contract to provide test operations support for the Science and Engineering Directorate of NASA's Marshall Space Flight Center in Huntsville, Alabama. The contract will start with a one-year basic period, followed by four one-year options, which may be exercised at NASA's discretion. If all options are exercised, the contract would be worth as much as \$30,930,739.

The work to be performed under the contract includes technician support to operate and maintain the test facilities in the propulsion laboratory at Marshall. LB&B is a small business involved in facilities management, propulsion testing, systems training, simulators and manufacturing.

Proposals for this work were solicited nationally. The procurement was handled under the Small Business Administration program limiting competition to qualified small and disadvantaged businesses. Marshall received a total of seven proposals. These services were previously provided by Consolidated Industries Inc. of Huntsville. ✱

For more information, contact Preston Jones at Marshall Space Flight Center. ☎ 256/544-5716, 📠 256/544-7454, ✉ [Preston.Jones@msfc.nasa.gov](mailto:Preston.Jones@msfc.nasa.gov) Please mention you read about it in *Innovation*.

make such a decision, it is because they do not know how many free spaces are available in real time, explained Merritt Systems' Chief Executive Officer Ronald L. Remus. He added that his company would like to use the sensor technology to help blind persons with wearable collision avoidance systems.

Applications are being considered for the smartSensor™ network to be installed around and within public parking garages. It would be linked to the garage computer with outdoor smart parking signs using wireless radio frequency modem links and back-lit light-emitted display (LED) or mechanical arrows with red and green blinking lights that show garages with available spaces. Inside the garage, smart routing signs mounted overhead or on poles in front of each row of parking spots would guide the motorist precisely to free spaces.

The sensors are immune to interference from metallic construction materials, such as rebar and steel beams, which degrade inductive loop accuracy and use noninvasive, reflective-ultrasonic technology for high accuracy, high reliability and low maintenance. The smartSensor™ system is inexpensive, remotely programmable and easy to install with new and retrofit installations mounted in any orientation. It has a license plate recognition feature that automatically reads and logs entering and exiting vehicle plate numbers. ✱

For more information, contact Ronald Remus at Merritt Systems. ☎ 407/380-6944, 📠 407/380-6102, ✉ [remus@pldaas.com](mailto:remus@pldaas.com) Please mention you read about it in *Innovation*.





## Biological Fluids Technology

### Optical Diagnostics of Biological Fluids and Tissues

NASA is seeking companies interested in commercializing a technology for studying and characterizing various biological fluids. A fiber-optic dynamic light scattering (DLS) probe has been developed at NASA's Lewis Research Center to study various biological fluids—a formidable challenge to the designers of optical diagnostics instrumentation because these fluids often contain a wide range of particulate matter. Conventional DLS is routinely used to characterize dilute macromolecular solutions in an effective size range of 3 nanometers to 3 millimeters. The fiber optic DLS probe developed by Lewis surpasses the bulkiness, poor sensitivity, long processing periods, and high-power and safety requirements of conventional DLS. The probe's compact system exploits the principles of DLS and offers a fast means of quantitatively and noninvasively characterizing various biological fluids, such as protein solutions, blood, viruses, spermatozoa and synovial fluids. It can also be used for single-angle static light-scattering measurements and analysis of skin and tissue. The benefits of this technology are that it is compact and portable, has flexible in-situ and in-vivo applications, offers low laser power (10 nanowatts to 3 milliwatts) and fast measurement time (5 to 30 seconds) and is equipped with a miniaturized microscope for visualizing macroscopic particles.

For more information, contact Dr. Rafat Ansari at Lewis Research Center.  
 ☎ 216/433-5008, ✉ [Rafat.R.Ansari@lerc.nasa.gov](mailto:Rafat.R.Ansari@lerc.nasa.gov) Please mention you read about it in *Innovation*.

### Preservative Coated Salivettes

NASA is seeking commercial applications of its Preservative Coated Salivettes (PCS), which allow for the storage of saliva samples in liquid form, at room temperature, for six months or longer. When a saliva sample is taken, the vial is centrifuged. This forces the saliva from the sample swab to the bottom of the vial, where a preservative coating dissolves in the saliva. This preserves the saliva sample for up to six months. The PCS technology has potential uses in environmental sampling of water or chemicals, which require preserved samples or later analysis.

The technology could be modified for the purpose of storing other biological samples, and it could be used for saliva sampling in remote locations and/or foreign markets. PCS doubles the shelf life of samples, reduces the costs related to refrigerated transportation and storage and allows extended storage capability without degradation to saliva samples. It could improve current screening processes for AIDS, hepatitis, measles and other diseases.

For more information, contact Dr. Lakshmi Putcha at Johnson Space Center.  
 ☎ 281/483-7760, ✉ [lakshmi.putcha1@jsc.nasa.gov](mailto:lakshmi.putcha1@jsc.nasa.gov) Please mention you read about it in *Innovation*.

### Whole Blood Staining Device

The Whole Blood Staining Device is a handheld, self-contained device that provides a means to stain white blood cells by using monoclonal antibodies conjugated to various fluorochromes, followed by lysing and fixing the cells using a diluted commercial reagent. It also provides a means to store whole blood safely in a refrigerator for up to 72 hours before processing and analysis. The Whole Blood Staining Device consists of a reagent tube, an injection site and two external clips. Potential markets are health care, government and military medical testing, as well as National Institutes of Health and Center for Disease Control testing in remote locations or sites established to provide "outpost" operations for medical service and the treatment of disease. Small hospitals can also benefit by purchasing this single device, rather than buying expensive lysing equipment, large stocks of monoclonal-antibody reagents and a flow cytometer. It can be used to test the efficacy of therapeutic regimes, such as drug protocol in the treatment of AIDS or prenatal screening for genetic traits for couples desiring to have children. The Whole Blood Staining Device does not require power, precise mixing or incubation. It is inexpensive and easy to manufacture. The prototype of the technology is available at NASA's Johnson Space Center, and units are being manufactured for NASA use under government contract. ⚙

For more information, contact Dr. Clarence Sams at Johnson Space Center.  
 ☎ 281/483-7160, ✉ [clarence.sams1@jsc.nasa.gov](mailto:clarence.sams1@jsc.nasa.gov) Please mention you read about it in *Innovation*.

**Technology Opportunity Showcase** highlights some unique technologies that NASA has developed and which we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in *Innovation*.



## NASA Field Centers

### Ames Research Center

Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

### Carolina Blake

Ames Research Center  
Moffett Field, California 94035-1000  
650/604-0893  
[cblake@mail.arc.nasa.gov](mailto:cblake@mail.arc.nasa.gov)

### Dryden Flight Research Center

Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

### Eugene (Lee) Duke

Dryden Flight Research Center  
Edwards, California 93523-0273  
805/258-3802  
[lee.duke@dfrc.nasa.gov](mailto:lee.duke@dfrc.nasa.gov)

### Goddard Space Flight Center

Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

### George Alcorn

Goddard Space Flight Center  
Greenbelt, Maryland 20771  
301/286-5810  
[george.e.alcorn.1@gsfc.nasa.gov](mailto:george.e.alcorn.1@gsfc.nasa.gov)

### Jet Propulsion Laboratory

Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics, and Autonomous Systems.

### Merle McKenzie

Jet Propulsion Laboratory  
Pasadena, California 91109  
818/354-2577  
[merle.mckenzie@jpl.nasa.gov](mailto:merle.mckenzie@jpl.nasa.gov)

### Johnson Space Center

Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations

### Henry (Hank) Davis

Johnson Space Center  
Houston, Texas 77058  
281/483-0474  
[henry.l.davis@jsc.nasa.gov](mailto:henry.l.davis@jsc.nasa.gov)

### Kennedy Space Center

Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

### Gale Allen

Kennedy Space Center  
Kennedy Space Center,  
Florida 32899  
407/867-6226  
[gale.allen-1@kmail.ksc.nasa.gov](mailto:gale.allen-1@kmail.ksc.nasa.gov)

### Langley Research Center

Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

### Joe Heyman

Langley Research Center  
Hampton, Virginia 23681-0001  
757/864-6005  
[j.s.heyman@larc.nasa.gov](mailto:j.s.heyman@larc.nasa.gov)

### Lewis Research Center

Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High Temperature Materials Research, Microgravity Science and Technology and Instrumentation Control Systems.

### Larry Viterna

Lewis Research Center  
Cleveland, Ohio 44135  
216/433-3484  
[Larry.A.Viterna@lerc.nasa.gov](mailto:Larry.A.Viterna@lerc.nasa.gov)

### Marshall Space Flight Center

Selected technological strengths are Materials, Manufacturing, Non-destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

### Sally Little

Marshall Space Flight Center  
Huntsville, Alabama 35812  
256/544-4266  
[sally.little@msfc.nasa.gov](mailto:sally.little@msfc.nasa.gov)

### Stennis Space Center

Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Nonintrusive Instrumentation.

### Kirk Sharp

Stennis Space Center  
Stennis Space Center, Mississippi  
39529-6000  
601/688-1914  
[kirk.sharp@ssc.nasa.gov](mailto:kirk.sharp@ssc.nasa.gov)

## NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Joseph C. Boeddeker  
**Ames Technology Commercialization Center**  
San Jose, CA  
408/557-6789

Lyn Stabler (Acting)  
**Mississippi Enterprise for Technology**  
Stennis Space Center, MS  
601/688-3144

Wayne P. Zeman  
**Lewis Incubator for Technology**  
Cleveland, OH  
216/586-3888

Thomas G. Rainey  
**Florida/NASA Business Incubation Center**  
Titusville, FL  
407/383-5200

## Small Business Programs

Carl Ray  
NASA Headquarters  
**Small Business Innovation Research Program (SBIR/STTR)**  
202/358-4652  
[cray@hq.nasa.gov](mailto:cray@hq.nasa.gov)

Paul Mexcur  
Goddard Space Flight Center  
**Small Business Technology Transfer (SBIR/STTR)**  
301/286-8888  
[paul.mexcur@pop700.gsfc.nasa.gov](mailto:paul.mexcur@pop700.gsfc.nasa.gov)

## NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

Ken Dozier  
**Far West Technology Transfer Center**  
University of Southern California  
213/743-2353

Dr. William Gasko  
**Center for Technology Commercialization**  
508/870-0042

J. Ronald Thornton  
**Southern Technology Applications Center**  
University of Florida  
352/294-7822

Gary F. Sera  
**Mid-Continent Technology Transfer Center**  
Texas A&M University  
409/845-8762

Lani S. Hummel  
**Mid-Atlantic Technology Applications Center**  
University of Pittsburgh  
412/383-2500

Christopher Coburn  
**Great Lakes Industrial Technology Center**  
Battelle Memorial Institute  
440/734-0094

Joseph P. Allen  
**National Technology Transfer Center**  
Wheeling Jesuit University  
800/678-6882

Doris Rouse  
**Research Triangle Institute Technology Applications Team**  
Research Triangle Park, NC  
919/541-6980

## NASA ON-LINE

Go to **NASA's Commercial Technology Network (CTN)** on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

NASA's Langley Research Center will host the ***International Forum on Aeroelasticity and Structural Dynamics*** in Williamsburg, Virginia, on June 22–25, 1999. This major international event is jointly sponsored by the Confederation of European Aerospace Societies, the American Institute of Aeronautics and Astronautics and the Institute for Computer Applications in Science and Engineering. The forum provides a comprehensive survey of the current status of research and development for aircraft and spacecraft. It provides an international forum for scientists and engineers from industry, government and universities to exchange knowledge and results of current studies and to discuss directions for future research. For more information, contact Emily Todd at Langley. ☎ 757/864-2175, 📠 757/864-6134, ✉ [emily@icase.edu](mailto:emily@icase.edu) 🌟



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